

### Claims

What is claimed is:

- 1    1.    An integrated paper having active particles immobilized therein, said  
2    integrated paper comprising of:  
3            a plurality of fibers fibrillated at a temperature greater than about  
4            30°C, wherein said fibrillated fibers have an average fiber diameter of  
5            less than about 1000 nm; and  
6            active agents comprising metals, metal salts, metal oxides,  
7            alumina, carbon, activated carbon, silicates, ceramics, zeolites,  
8            diatomaceous earth, activated bauxite, fuller's earth, calcium sulfate,  
9            titanium dioxide, magnesia, magnesium hydroxide, magnesium oxide,  
10           manganese oxides, iron oxides, perlite, talc, clay, bone char, calcium  
11           hydroxide, calcium salts, or combinations thereof,  
12    wherein said integrated paper has a mean pore size of less than or equal to  
13    about 2  $\mu\text{m}$ .
- 1    2.    An integrated paper of claim 1 wherein said fibrillated fibers comprise  
2    lyocell.
- 1    3.    An integrated paper of claim 2 wherein the lyocell has an average fiber  
2    diameter of less than about 400 nm.
- 1    4.    An integrated paper of claim 1 wherein said active agents have an  
2    average particle size of less than or equal to about 1  $\mu\text{m}$  to about 5000  $\mu\text{m}$ .
- 1    5.    An integrated paper of claim 1 wherein the average diameter of said  
2    fibrillated fibers is less than an average particle size of said active agents.
- 1    6.    An integrated paper of claim 1 further including binder fibers or  
2    particles.

1 7. An integrated paper of claim 1 wherein said fibrillated fibers and said  
2 active agents have different settling velocities such that said integrated paper  
3 has an asymmetric structure when formed by wet-laid processes.

1 8. An integrated paper of claim 1 further including a microbiological  
2 interception enhancing agent.

1 9. An integrated paper comprising of:  
2 a plurality of fibers fibrillated at a temperature greater than about  
3 30°C, wherein said fibrillated fibers have an average fiber diameter of  
4 less than about 400 nm; and  
5 silver oxide particles admixed with said fibrillated fibers.

1 10. An integrated paper of claim 9 wherein the fibrillated fibers comprise a  
2 liquid crystal polymer.

1 11. An integrated paper comprising of:  
2 a plurality of fibers fibrillated at a temperature greater than about  
3 30°C, wherein said fibers have an average fiber diameter of less than  
4 about 400 nm; and  
5 one or more acid neutralizing agents admixed with said  
6 fibrillated fibers;  
7 wherein said integrated paper can withstand a hot and corrosive environment  
8 of a lube oil filter.

1 12. An integrated paper of claim 11 further including binder fibers or  
2 particles.

1 13. An integrated paper of claim 11 wherein said one or more acid  
2 neutralizing agents comprises magnesium oxide, magnesium hydroxide,  
3 calcium sulfonate, magnesium sulfonate, calcium phenate, magnesium  
4 phenate, or combinations thereof.

1 14. An integrated paper comprising of:  
2 a plurality of lyocell fibers fibrillated at a temperature greater  
3 than about 30°C, wherein said fibrillated lyocell fibers have an average  
4 fiber diameter of less than or equal to about 400 nm; and  
5 activated carbon particles admixed with said fibrillated lyocell  
6 fibers,  
7 wherein said integrated paper has a mean flow path of less than about 2  $\mu\text{m}$ .

1 15. An integrated paper of claim 14 further including a microbiological  
2 interception enhancing agent.

1 16. An integrated paper of claim 14 further including a heavy metal  
2 reducing agent.

1 17. An integrated paper of claim 16 wherein the heavy metal reduction  
2 agent comprises particles of zeolite, silicate, or combinations thereof.

1 18. An integrated paper of claim 14 further including an arsenic reducing  
2 agent.

1 19. An integrated paper of claim 18 wherein the arsenic reducing agent  
2 comprises particles of iron, oxides of manganese or iron, or combinations  
3 thereof.

1 20. An integrated paper comprising of:

2                   a plurality of fibers having an average fiber diameter of less than  
3                   about 1000 nm; and  
4                   a lead reducing agent admixed with said plurality of fibers,  
5   wherein said integrated paper has a mean flow path of less than about 2  $\mu\text{m}$ .

1   21.   An integrated paper of claim 20 further including a microbiological  
2   interception enhancing agent.

1   22.   An integrated paper of claim 20 further including binder fibers or  
2   particles.

1   23.   An integrated paper of claim 22 further including a microbiological  
2   interception enhancing agent.

1   24.   An integrated paper of claim 20 further including a carbon block,  
2   wherein said integrated paper is wrapped around the carbon block.

1   25.   An integrated paper of claim 24 further including a microbiological  
2   interception enhancing agent.

1   26.   A water filtration device comprising of:  
2                   a carbon block; and  
3                   an integrated paper upstream of said carbon block, said  
4                   integrated paper having a mean flow path of less than about 2  $\mu\text{m}$  and  
5                   comprising an admixture of:  
6                   fibrillated fibers having an average fiber diameter of less  
7                   than about 1000 nm; and  
8                   active agents comprising metals, metal salts, metal  
9                   oxides, alumina, carbon, activated carbon, silicates, ceramics,  
10                  zeolites, diatomaceous earth, activated bauxite, fuller's earth,

11 calcium sulfate, titanium dioxide, magnesia, magnesium  
12 hydroxide, magnesium oxide, manganese oxides, iron oxides,  
13 perlite, talc, clay, bone char, calcium hydroxide, calcium salts,  
14 or combinations thereof.

1 27. A filtration device of claim 26 wherein said integrated paper provides  
2 toxic material, and heavy metal reduction.

1 28. A filtration device of claim 26 wherein said integrated paper provides a  
2 water softening effect.

1 29. A filtration device of claim 26 further including a microbiological  
2 interception enhancing agent.

1 30. A gravity-flow water filtration device comprising of:  
2 a hydrophilic integrated paper having a mean flow path of less  
3 than about 2  $\mu\text{m}$  comprising of:  
4 fibrillated fibers having an average fiber diameter of less  
5 than about 400 nm; and  
6 particles of activated carbon, heavy metal reducing  
7 agents, arsenic reducing agents, chemisorbent agents, or  
8 combinations thereof;  
9 wherein said gravity-flow water filtration device has a flow rate of about 10 to  
10 about 1000 ml/minute when operated at a pressure of about 4 inches water  
11 column.

1 31. A filtration device of claim 30 wherein the fibrillated fibers are  
2 fibrillated at a temperature of greater than about 30°C.

1 32. A filtration device of claim 30 wherein the fibrillated fibers comprise  
2 lyocell.

1 33. A filtration device of claim 30 wherein the average fiber diameter of the  
2 fibrillated fibers is smaller than an average particle size of the activated carbon,  
3 heavy metal reducing agents, and chemisorbent agents.

1 34. A filtration device of claim 30 further including a microbiological  
2 interception enhancing agent.

1 35. A lube oil filtration device comprising of:  
2 an integrated paper in contact with said lube oil, said integrated  
3 paper comprising an admixture of:  
4 fibrillated fibers having an average fiber diameter of less  
5 than about 1000 nm; and  
6 an acid neutralizing agent.

1 36. A filtration device of claim 35 wherein the acid neutralizing agent  
2 comprises magnesium hydroxide or magnesium oxide.

1 37. An air treatment device for chemisorbing carbon dioxide, said device  
2 comprising of:  
3 an integrated paper comprising an admixture of fibrillated fibers  
4 having an average fiber diameter of less than about 1000 nm; and silver  
5 oxide,  
6 wherein the average fiber diameter of the fibrillated fibers is smaller than an  
7 average particle size of the silver oxide.

1 38. A method of immobilizing particles comprising of:

2            providing a plurality of active agents comprising metals, metal  
3            salts, metal oxides, alumina, carbon, activated carbon, silicates,  
4            ceramics, zeolites, diatomaceous earth, activated bauxite, fuller's earth,  
5            calcium sulfate, titanium dioxide, magnesia, magnesium hydroxide,  
6            magnesium oxide, manganese oxides, iron oxides, perlite, talc, clay,  
7            bone char, calcium hydroxide, calcium salts, or combinations thereof;  
8            providing a plurality of fibers wherein at least a portion of the  
9            fibers have an average fiber diameter that is smaller than an average  
10           particle size of the active particles;  
11           admixing the active agents and the fibers; and  
12           forming an integrated paper having a mean flow path of less  
13           than about 2  $\mu\text{m}$  with the admixture of active agents and fibers.

1    39.    A method of claim 38 wherein in the step of providing a plurality of  
2    fibers, the plurality of fibers are produced by fibrillation at temperatures of  
3    greater than about 30°C.

1    40.    A method of claim 38 wherein in the step of forming the paper, the  
2    paper is loaded with active particles up to about 95% by weight of the  
3    integrated paper.